PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F16F 15/124, B25F 3/00, B25B 23/00 | A1

(11) International Publication Number: WO 96/21113

(43) International Publication Date: 11 July 1996 (11.07.96)

(21) International Application Number: PCT/CA95/00732

(22) International Filing Date: 29 December 1995 (29.12.95)

(30) Priority Data:

| | | |
|---|---|---|
| 2,134,949 | 29 December 1994 (29.12.94) | CA |
| 2,135,947 | 16 March 1995 (16.03.95) | CA |
| 08/510,364 | 2 August 1995 (02.08.95) | US |


(71) Applicant *(for all designated States except US)*: 1134564 ONTARIO INC. [CA/CA]; R.R. #4, Ingersoll, Ontario N5C 3J7 (CA).

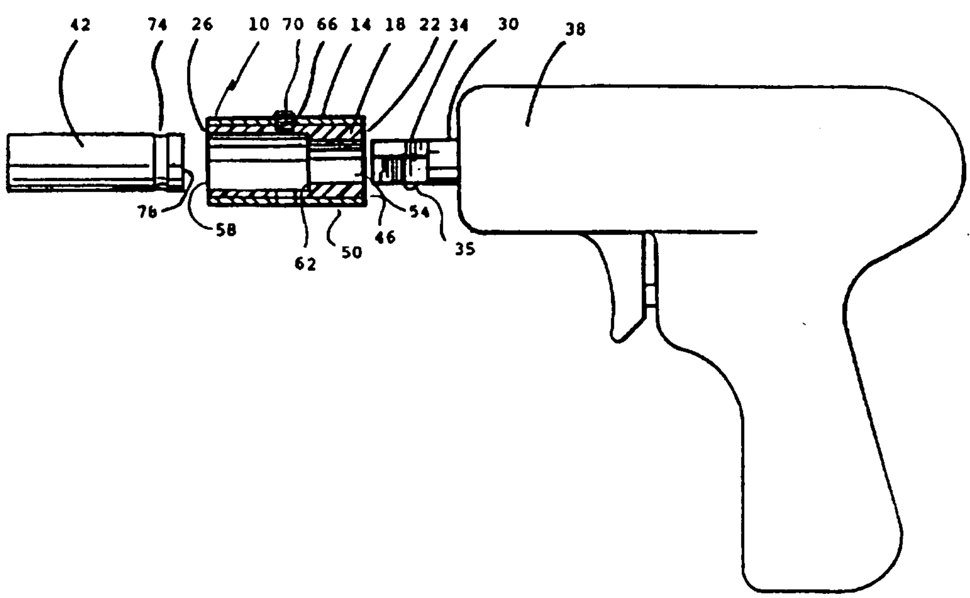
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: BARNES, George, Edward [CA/CA]; R.R. #5, Ingersoll, Ontario N5C 3J8 (CA).

(74) Agents: MUSCAT, Austin, A. et al.; McCarthy Tétrault, Toronto Dominion Bank Tower, Suite 4700, Toronto-Dominion Centre, Toronto, Ontario M5K 1E6 (CA).


(81) Designated States: AL, AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

**Published**
*With international search report.*


(54) Title: ANTI-VIBRATION ADAPTOR




(57) Abstract

An anti-vibration adaptor having a wear resistant, vibration absorbing sleeve which mounts over the conventional releasable connection between a socket wrench and drive wrench. The adaptor substantially reduces run-out which is typical to conventional relatively loose mating socket connections and which are prone to excessive vibration and losses in torque. Consequently, the adaptor substantially increases torque imparted to a fastener and significantly decreases vibration experienced by an operator, thereby improving the quality of the driven fasteners and decreasing the chance of operator injury.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | |
|---|---|
| AM | Armenia |
| AT | Austria |
| AU | Australia |
| BB | Barbados |
| BE | Belgium |
| BF | Burkina Faso |
| BG | Bulgaria |
| BJ | Benin |
| BR | Brazil |
| BY | Belarus |
| CA | Canada |
| CF | Central African Republic |
| CG | Congo |
| CH | Switzerland |
| CI | Côte d'Ivoire |
| CM | Cameroon |
| CN | China |
| CS | Czechoslovakia |
| CZ | Czech Republic |
| DE | Germany |
| DK | Denmark |
| EE | Estonia |
| ES | Spain |
| FI | Finland |
| FR | France |
| GA | Gabon |
| GB | United Kingdom |
| GE | Georgia |
| GN | Guinea |
| GR | Greece |
| HU | Hungary |
| IE | Ireland |
| IT | Italy |
| JP | Japan |
| KE | Kenya |
| KG | Kyrgystan |
| KP | Democratic People's Republic of Korea |
| KR | Republic of Korea |
| KZ | Kazakhstan |
| LI | Liechtenstein |
| LK | Sri Lanka |
| LR | Liberia |
| LT | Lithuania |
| LU | Luxembourg |
| LV | Latvia |
| MC | Monaco |
| MD | Republic of Moldova |
| MG | Madagascar |
| ML | Mali |
| MN | Mongolia |
| MR | Mauritania |
| MW | Malawi |
| MX | Mexico |
| NE | Niger |
| NL | Netherlands |
| NO | Norway |
| NZ | New Zealand |
| PL | Poland |
| PT | Portugal |
| RO | Romania |
| RU | Russian Federation |
| SD | Sudan |
| SE | Sweden |
| SG | Singapore |
| SI | Slovenia |
| SK | Slovakia |
| SN | Senegal |
| SZ | Swaziland |
| TD | Chad |
| TG | Togo |
| TJ | Tajikistan |
| TT | Trinidad and Tobago |
| UA | Ukraine |
| UG | Uganda |
| US | United States of America |
| UZ | Uzbekistan |
| VN | Viet Nam |

# ANTI-VIBRATION ADAPTOR

## TECHNICAL FIELD

The present invention relates to anti-vibration adaptors. More specifically, the present invention relates to anti-vibration adaptors which, when employed in conjunction with powered fastener drivers and socket-type driven heads, increase torque transmitted to a fastener and decreases vibration experienced by the fastener driver which is subsequently transmitted to an operator.

## BACKGROUND ART

Power fastener drivers such as pneumatic or electric powered pulse and/or impact wrenches as well as anglehead and/or straight nutrunners, referred to herein simply as drivers, are well known in industrial environments. In particular, in the automotive industry, these types of drivers are used extensively in the assembly of automobiles. Typically, such drivers comprise a pistol or club-style main body, a trigger, air line connections and a drive shaft which removably connects with a plurality of driver heads and/or extension shafts.

The driver heads comprise a plurality of various sized Imperial or SAE type sockets and screwdriver fittings, herein referred to simply as sockets, all of which are used to drive, or "run-down" a variety of fasteners including nuts and bolts. The variety of the sockets available also varies with the head style of the fastener. For example, while hexagonal type bolt heads are common, Allen-type bolts and Torx®-head bolts are also used extensively in the automotive industry in a variety of sizes. Typically, the connection between the driver and the socket is accomplished via a female square drive connector on the socket and a complementary male square drive connector on the driver which may be snapped together by means of a spring pin disposed through the surface on the male square drive connector. However, other snap-

on connector profiles are available which are equally effective. Generally, these tools are designed to enable the operator to quickly change sockets depending on the size or head style of the fastener to be run-down, hence the popularity of these types of snap-on connections. However, due to the frequency of socket changes and the fact that the sockets are mass produced items, the majority of these type of drivers and sockets, including automotive industrial grade tooling, are not designed to close tolerances and have relatively large mating clearances. In most instances, the resulting connection between the driver and the socket will suffer what is known as "run-out" which is the ability of the socket to rotate back and forth about its longitudinal center axis and to undergo a side to side wobble.

In use, the run-out in the connections, the speed of rotation and the pulsing or impacting action of the wrench results in vibration of the driver and socket components relative to each other. Consequently, the tool operator is exposed to this vibration which is transferred through the tool to the operator's hands and arms. In an environment such as the automotive industry where a typical assembly worker's primary function is to operate these drivers, this vibration can cause serious physical injury. Further, the vibration results in substantially elevated noise levels which can result in the operator suffering permanent hearing loss if exposed for sufficient periods of time.

Vibration resulting from this run-out has other detrimental effects. In particular, excessive vibration can cause premature break down of the internal bearings in the wrenches which reduces driver life. Further, in many circumstances, such as the production of automobiles, fasteners are designed to be installed with a specified torque to which the drivers are preset. However, the above-described vibration results in losses in torque which consequently result in fasteners which are not tightened to specification during production and/or which results in poor statistical process control.

Overall, the above-identified disadvantages of typical socket-driver connections result in torque losses, quality control and operator health problems which increase manufacturing costs and/or reduce final product quality. Therefore, there is a long standing need in industry for an apparatus which improves the above-identified socket-driver connections to substantially reduce run-out.

## DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a novel anti-vibration adaptor which obviates or mitigates at least one of the above-described disadvantages of the prior art.

According to one aspect of the present invention, there is provided an anti-vibration adaptor for use with a connection between a driving means and a driven member, comprising: a resilient damping means to encompass said connection between the driving means and the driven member, the resilient damping means receiving each of the driving means and the driven member with negligible clearance to reduce run-out which would otherwise occur in the connection; and, a housing within which the resilient damping means is substantially disposed.

According to another aspect of the present invention there is provided a fastener driving tool comprising: a fastener driver including a driving means; a fastener driving head connected to said driving means; a housing; a resilient damping means disposed in said housing and having a first bore disposed in one end and a second bore disposed at an opposing end, said first and second bores being coaxially aligned and in communication, said first bore receiving an end of said driving means distal said fastener driver with negligible clearance and said second bore receiving said fastener driving head with negligible clearance such that said connection therebetween is disposed

within said resilient damping means to reduce run-out which would otherwise occur in said connection.

Preferably, the resilient damping means the present invention comprises a sleeve having a first bore which receives at least a portion of the driving means and a coaxially aligned second bore which receives at least a portion of the driven member.

Also preferably, the driving means used in the present invention is a fastener driver.

Also preferably, the housing of the present invention comprises a bearing, the bearing acting between part of the fastener driver and the resilient damping means such that the resilient damping means is rotatable with respect to the fastener driver.

Also preferably, the driven means used with the present invention comprises a female receptacle to receive one of a fastener driving head and an extension shaft.

## BRIEF DESCRIPTION OF THE DRAWINGS

Presently preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows an exploded assembly of a pulse wrench, a socket and a section of an anti-vibration adaptor in accordance with an embodiment of the present invention;

Figure 2 shows a section view of the anti-vibration adaptor of Figure 1 mounted to the socket and connected to one end of a conventional

extension shaft, the extension shaft having a second anti-vibration adaptor mounted to an opposing end thereof;

Figure 3 shows a perspective view of a right angle tool fitted with the anti-vibration adaptor of Figure 1 and a tool mounted anti-vibration adaptor in accordance with a second embodiment of the present invention; and,

Figure 4 shows a section view of the tool mounted anti-vibration adaptor of Figure 3 taken along line 4-4.

## BEST MODE OF CARRYING OUT THE INVENTION

An anti-vibration adaptor in accordance with the present invention is shown in Figure 1 and is indicated generally at 10. Adaptor 10 generally comprises a housing 14, a resilient damping means, which in the presently preferred embodiment comprises a damping sleeve 18 having a pair of ends 22 and 26. End 22 is sized to engage a shaft 30 and square drive 34 of a conventional driver such as pulse wrench 38 while end 26 is sized to engage a conventional socket 42. Pulse wrench 38 may be any conventional pneumatic or electric driver, as previously described, which typically accommodates ¼", ⅜" or ½" square or hexagonal drive type sockets 42. However, adaptor 10 may be sized to accommodate smaller or larger type socket wrench systems with a variety of drive configurations.

Housing 14 is generally cylindrical, annular in cross-section and preferably is formed from stainless steel or aluminum having generally smooth inner and outer diameters 46 and 50 respectively. However, it is contemplated that housing 14 may be formed from any suitable material such as steel, brass, copper, titanium, cast iron, composites such as fibreglass or carbon fibre and plastics. Damping sleeve 18, is provided with an outer diameter which is sized for interference press fit engagement with inner diameter 46 of housing 14 and is of a length which is substantially equal to the length of housing 14.

Damping sleeve 18 is provided with a centrally located, longitudinal first bore 54, located adjacent end 22 and in communication with a longitudinal second bore 58 adjacent end 26, coaxially aligned with first bore 54. Preferably, damping sleeve 18 is formed from Ultra High Molecular Weight polyethylene (UHMW) such as that manufactured by the Cadillac Plastic & Chemical Company, (CADCO)® of Troy Michigan, in the United States. UHMW is presently preferred as it provides a high degree of abrasion resistance and has a relatively low coefficient of friction which provides for a longer life cycle and good vibration damping properties.

First bore 54 has a diameter which is selected to provide minimal clearance around square drive 34 and shaft 30 of pulse wrench 38 and is of a length which allows square drive 34 to pass into second bore 58. Second bore 58, is sized to removably receive socket 42 and to permit engagement of the socket with square drive 34 in a conventional manner. As shown in Figure 1, the diameter of second bore 58 is such that a seat 62 is formed at the junction of first bore 54 and second bore 58 which serves to locate socket 42 when positioned therein. A means to fix adaptor 10 relative to socket 42 is provided.

In the presently preferred embodiment, the means to fix is at least one threaded bore 66 which passes radially through housing 14 and damping sleeve 18 to second bore 58 and is longitudinally positioned to permit a grub screw 70 or other suitable fastener, threaded therein, to engage a bored hole 74, dimple or retaining groove on socket 42. It is contemplated that other means of fixing adaptor 10 relative to socket 42 may also be employed, such as high strength glue, a key groove cut into socket 42 with a complementary key ridge in bore 58 etc.

To employ the present invention, socket 42 is placed through end 26 into second bore 58 until it is seated firmly against seat 62. Grub screw 70

is then screwed through threaded bore 66 to engage bored hole 74, thereby securing socket 42 in place. Adaptor 10, disposed over socket 42, is then placed onto pulse wrench 38 by inserting square drive 34 and shaft 30 into end 22 and first bore 54. Square drive 34 passes through first bore 54 and engages a complementary female connector 78 on the rear face of socket 42 in a conventional manner. A spring retainer 35, disposed through the surface of square drive 34, retains socket 42 also in a conventional manner. When fully assembled, the clearance between shaft 30 and first bore 54 is negligible as is the clearance between socket 42 and second bore 58. Consequently, adaptor 10 surrounds the conventional square drive joint between socket 42 and square drive 34.

In operation, damping sleeve 18 serves two purposes. First, as bore 54 is sized with negligible clearance to square drive 34 and shaft 30 and bore 58 is sized with negligible clearance to socket 42, run-out at the removable connection is reduced. The reduction in run-out results in less vibration being produced by the connection and more torque being transferred to socket 42.

Second, the UHMW material used in damping sleeve 18 absorbs a portion of the vibration which is created, thus damping the vibration that is experienced by the driver and which gets transmitted to the tool operator.

As shown in Figure 2, when pulse wrench 38 is used in conjunction with a shaft extension 100, additional vibration reduction can be achieved by using a second anti-vibration adaptor 104. Shaft extension 100 is of the conventional type and is provided with a square drive connector female end 108 and a square drive connector male end 110. Adaptor 104, is substantially similar to adaptor 10, like elements being indicated with primed numerals. In this embodiment, second bore 58' is sized to accommodate

female end 108 and threaded bore 66' is positioned along housing 14' such that grub screw 70' will engage with a bored hole 112, dimple or retainer groove on female end 108 of shaft extension 100.

Second bore 58' is sized to create an interference fit when placed over female end 108 with negligible clearance thereby establishing a fixed connection between adaptor 104 and shaft extension 100. In practice, engagement of adaptor 104 and shaft extension 100 is accomplished by lightly press fitting the components together. This is achieved by pressing second bore 58' of adaptor 104 over female end 108 until in a fully seated position as indicated in Figure 2. However, it is contemplated that it is possible to size second bore 58' with a small clearance to create a releasable connection between female end 108 and second bore 58'. Provided that this clearance maintains a connection which is substantially free from any run-out, the anti-vibration characteristics of adapter 104 should not be unduly compromised.

First bore 54' is preferably sized to removably receive shaft 30 and square drive 34 in a manner substantially identical to the connection of adaptor 10 and pulse wrench 38 of Figure 1.

Similarly, adaptor 10 and socket 42 mounted therein installs to male end 110 of extension shaft 100 in an manner identical to the installation of the adaptor to pulse wrench 38, as described with respect to Figure 1.

Performance testing of adaptors 10 and 104 was performed using a 12 mm socket, a 6" extension shaft mounted to a Uryu UX500 Pulse wrench having a 3/8" square drive. The socket, extension shaft and adaptors were all new and the pulse wrench was rebuilt to new conditions. Comparison measurements for torque and vibration were made with this configuration with and without adaptors 10 and 104. The test was conducted in an automotive

production environment, specifically a bumper installation application, in which five fastener run-downs were required per vehicle. Initial torque settings for each pulse wrench was made with a Uryu UET200 torque setting tool. Torque measurements were made prior to installation using a Tonichi torque wrench. Vibration measurements were made at the pulse wrench using an SKF CMVP20 Vibration Check Unit.

The results obtained are as follows. Initial measurements of the pulse wrench were conducted with the torque set at 200 kgf-cm indicated a 32.14% increase in static torque measured on the fastener and a 97.35% decrease in vibration at the tool when adaptors 10 and 104 were used compared to the control case without adaptors 10 and 104.

After 50,000 fastener rundowns, to determine the effect of wear on the results, measurements conducted with the torque set at 250 kgf-cm indicated a 21% increase in static torque measured on the fastener and a 94.2% decrease in vibration at the tool when adaptors 10 and 104 were used compared to the control case without adaptors 10 and 104.

These tests were again performed after 225,000 fastener rundowns, with measurements conducted with the torque set at 220 kg/f-cm and a 12.5% increase in static torque was measured on the fastener and a 95.9% decrease in vibration at the tool was measured when adaptors 10 and 104 were used compared to the control case without adaptors 10 and 104. 225,000 rundowns is representative of the full life of adaptors 10 and 104. These results clearly indicate that significant increases in torque and decreases in vibration experienced by the operator can be achieved when adaptors 10 and 104 are employed.

A similar test was performed using the above-identified equipment but instead using a single adaptor mounted directly to the pulse wrench with no shaft extension in place. The results indicated a 92.35% reduction in vibration at the tool and an increase in fastener torque of 18.2%.

In some situations the present inventors have found it advantageous to employ an anti-vibration adaptor which physically mounts to the body of the tool. Figure 3 shows such a situation in which an anti-vibration adaptor, generally indicated at 204 is directly mounted to a tool 200 which for example purposes, is illustrated as a right angle tool. However, tool 200 may be any suitable straight nutrunner, multi-head driver or similar tool as previously described. Adaptor 204, as seen in section in Figure 4, generally comprises a housing 208 having a pair of ends 212 and 216, a bearing 220 and a damping means, which in the presently preferred embodiment comprises a damping sleeve 224.

Housing 208 is generally cylindrical and annular in cross-section and preferably formed from stainless steel or aluminum although other materials such as the above-described materials with respect to Figure 1 may be employed. Housing 208 adjacent end 216 is provided with a first bore 228 which is sized to removably engage a body portion 232 of tool 200, centered about a square drive 234. Housing 208 is secured to tool 200 using suitable fixing means, such as three grub screws 236 circumferentially spaced 120° apart. For other tools fixing means may be a threaded portion on housing 208 which engages a complementary threaded portion on tool 200 or any other suitable method of fixing adaptor 204 to tool 200 as would occur to those of skill in the art.

A longitudinally oriented second bore 240 is located in a mid portion of housing 208 and is coaxially aligned and in communication with first

bore 228. Second bore 240 is sized to freely accommodate shaft extension 100 which mounts to a square drive 234 in a conventional manner.

A longitudinal third bore 244, is coaxially aligned and in communication with second bore 240, adjacent end 212. Third bore 244 is sized to accommodate bearing 220 which abuts a seat 248 formed at the union of second and third bores 240, 244 respectively. A groove 252 is provided in the wall of third bore 244 adjacent bearing 220 which receives a snap ring 254 for the purposes of retaining bearing 220 in position.

Damping sleeve 224 is an annular member which is provided with an outer diameter sized for an interference press-fit engagement with the inner diameter of bearing 220. The outer diameter of damping sleeve 224 includes a shoulder 262 at each longitudinal end. The spacing between shoulders 262 substantially corresponding to the longitudinal length of the inner diameter of bearing 220. Damping sleeve 224 is press-fit into bearing 220 such that shoulders 262 abut bearing 220 to maintain damping sleeve 224 in place. As with the other previously described damping sleeves, damping sleeve 224 is preferably formed from UHMW such as that manufactured by CADCO® which offers a relatively high degree of abrasion resistance and a relatively low coefficient of friction. Damping sleeve 224 has an inner diameter 258 which is sized to fit around shaft extension 100 with negligible clearance.

In operation, female end 108 of shaft extension 100 is fitted to square drive 234 of tool 200 and is retained by a conventional spring pin 235. Male end 110 of shaft extension 100 is pressed through inner diameter 258 of damping sleeve 224 until first bore 232 slides over and is seated on tool housing 228. Once seated, grub screws 236 are tightened onto tool 200 to secure adaptor 204 in place.

In addition to adaptor 204, tool 200 may also preferably employ adaptor 10 at socket 42. In either case, adaptor 204 reduces the vibration experienced by the tool operator and increases the torque transmitted to shaft 100 in a manner similar to that described above in regard to adaptor 10.

The present invention has been described with reference to a presently preferred embodiment. Other variations and embodiments of the present invention may be apparent to those of ordinary skill in the art. Accordingly, the scope of protection sought for the present invention is only limited as set out in the attached claims.

What is claimed is:

1. An anti-vibration adaptor for use with a connection between a driving means and a driven member, comprising:

a resilient damping means to encompass said connection between said driving means and said driven member, said resilient damping means receiving each of said driving means and said driven member with negligible clearance to reduce run-out which would otherwise occur in said connection; and

a housing within which said resilient damping means is substantially disposed.

2. An anti-vibration adaptor according to claim 1 wherein said resilient damping means comprises a sleeve having a first bore which receives at least a portion of said driving means and a coaxially aligned second bore which receives at least a portion of said driven member.

3. An anti-vibration adaptor according to claim 1 wherein said driving means is a fastener driver.

4. An anti-vibration adaptor according to claim 3 wherein said housing comprises a bearing, said bearing acting between part of said fastener driver and said resilient damping means such that said resilient damping means is rotatable with respect to said fastener driver.

5. An anti-vibration adaptor according to claim 4 wherein said driven means comprises an extension shaft.

6. An anti-vibration adaptor according to claim 4 wherein said driven means comprises a female receptacle to receive one of a fastener driving head and an extension shaft.

7. An anti-vibration adaptor according to claim 1 wherein said driving means is an extension shaft.

8. An anti-vibration adaptor according to claim 7 further comprising means to fix said housing relative to said extension shaft.

9. An anti-vibration adaptor according to claim 1 wherein said driven means is one of a fastener driving head and an extension shaft.

10. An anti-vibration adaptor according to claim 9 further comprising means to fix said housing relative to said one of a fastener head and an extension shaft.

11. An anti-vibration adaptor according to claim 2 wherein said housing is a hollow cylindrical member.

12. An anti-vibration adaptor according to claim 11 wherein said resilient damping means is sized to form an interference fit with said housing.

13. An anti-vibration adaptor according to claim 1 wherein said housing is formed from at least one of steel, stainless steel, aluminum, cast iron, copper, brass, titanium, fibreglass, carbon fibre composite and plastic.

14. An anti-vibration adaptor according to claim 1 wherein said resilient damping means is formed from Ultra High Molecular Weight Polyethylene (UHMW).

15. An anti-vibration adaptor according to claim 1 wherein said fastener driver comprises one of a pneumatic pulse wrench, a pneumatic impact wrench, an electric pulse wrench and an electric impact wrench.

16. A fastener driving tool comprising:

a fastener driver including a driving means;

a fastener driving head connected to said driving means;

a housing;

a resilient damping means disposed in said housing and having a first bore disposed in one end and a second bore disposed at an opposing end, said first and second bores being coaxially aligned and in communication, said first bore receiving an end of said driving means distal said fastener driver with negligible clearance and said second bore receiving said fastener driving head with negligible clearance such that said connection therebetween is disposed within said resilient damping means to reduce run-out which would otherwise occur in said connection.

17. A fastener driving tool according to claim 16 wherein said housing comprises a bearing acting between said fastener driver and a second resilient damping means which encompasses an end of said driving means within said fastener driver, said second resilient damping means rotating with said driving means.

18. A fastener driving tool according to claim 17 wherein said driving means comprises an extension shaft.

19. A fastener driving tool according to claim 18 further comprising means to fix said housing relative to said extension shaft.

20. A fastener driving tool according to claim 16 wherein said driving means comprises a female receptacle to receive one of a fastener driving head and an extension shaft.

21. A fastener driving tool according to claim 16 wherein said resilient damping means is sized to form an interference fit with said housing.

22. A fastener driving tool according to claim 16 wherein said housing is formed from at least one of steel, stainless steel, aluminum, cast iron, copper, brass, titanium, fibreglass, carbon fibre composite and plastic.

23. A fastener driving tool according to claim 16 wherein said resilient damping means is formed from Ultra High Molecular Weight Polyethylene (UHMW).

24. A fastener driving tool according to claim 16 wherein said fastener driver comprises one of a pneumatic pulse wrench, a pneumatic impact wrench, an electric pulse wrench and an electric impact wrench.

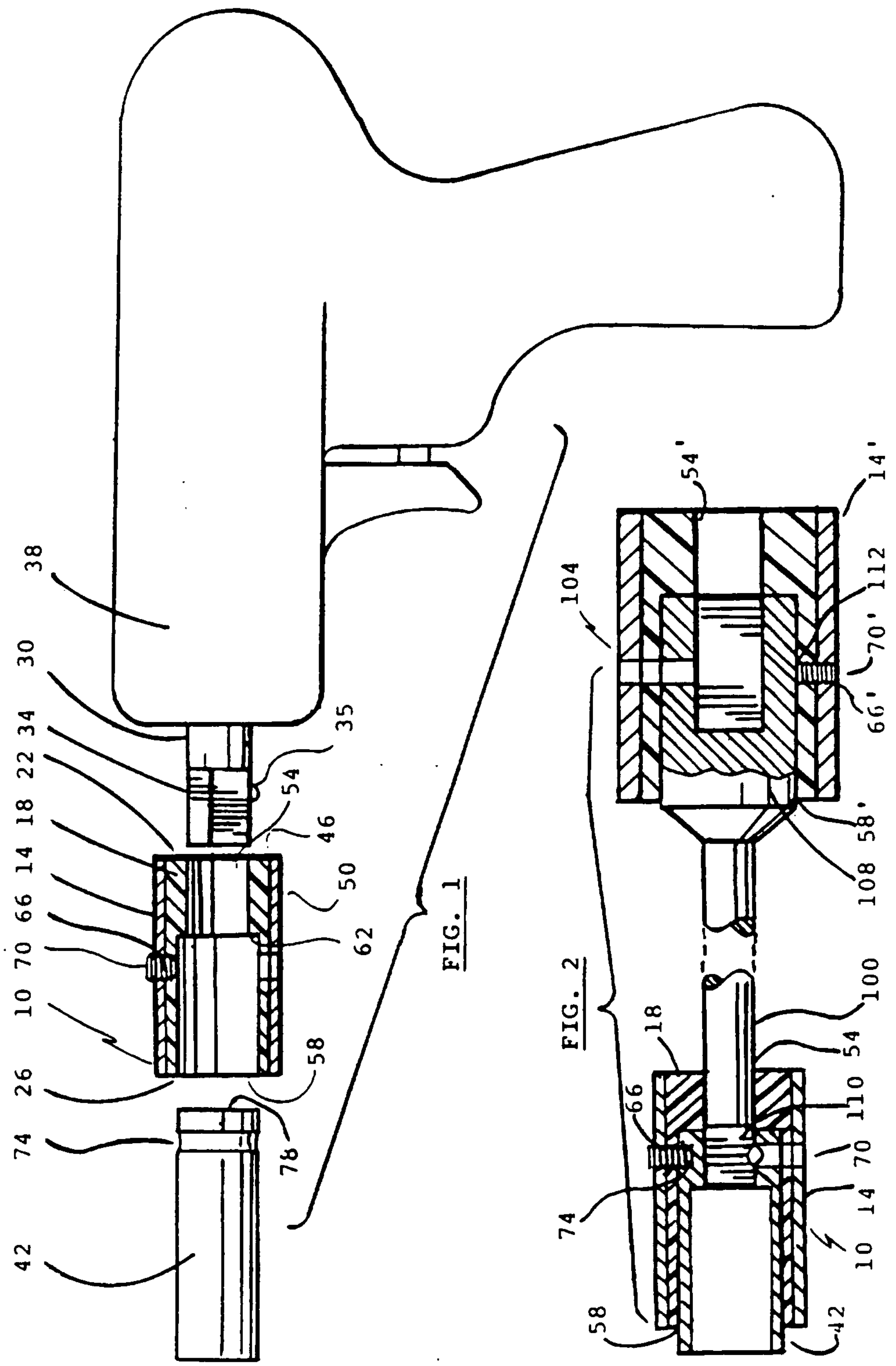


FIG. 1
FIG. 2
38
30
34
22
18
14
66
70
10
26
74
42
35
54
46
50
62
58
78
104
54'
14'
112
70'
66'
58'
108
100
54
110
70
14
10
42
58
74
66
18

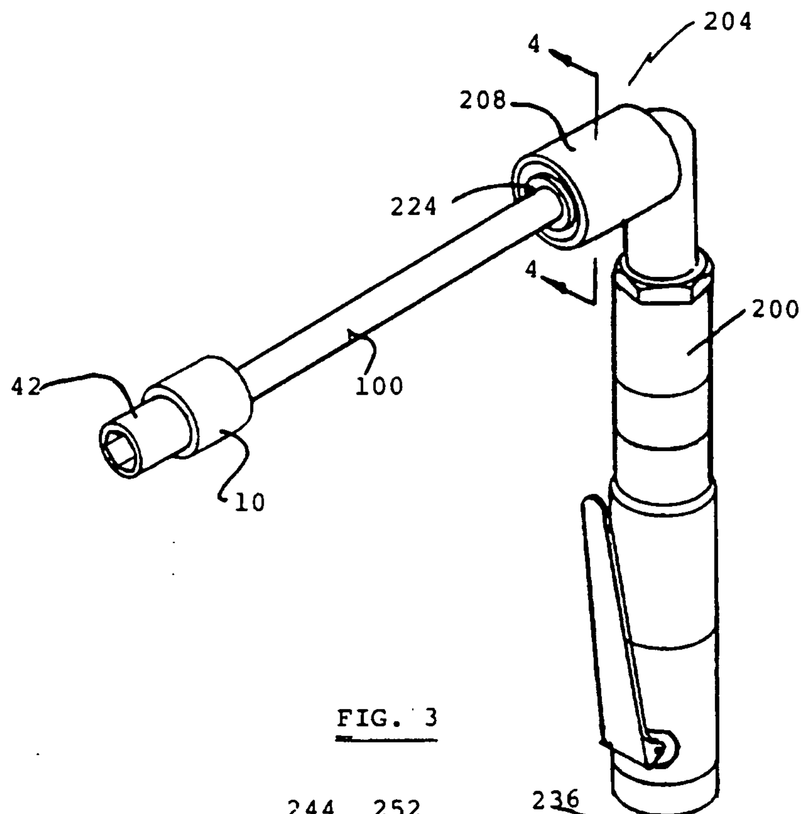

204
4
208
224
4
200
42
100
10

FIG. 3

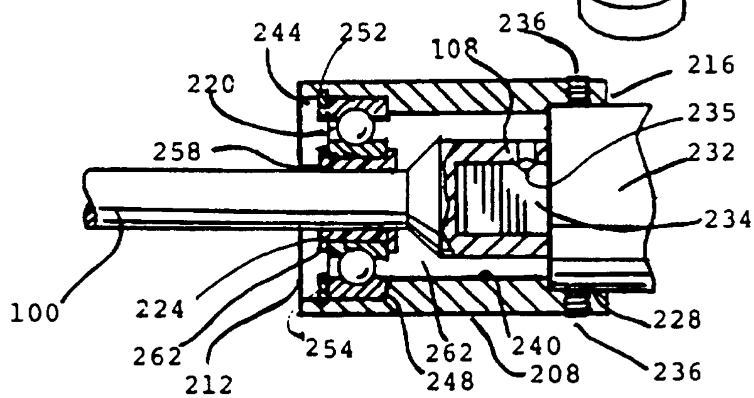

244
252
236
108
216
220
235
258
232
234
100
224
262
212
254
262
248
240
208
228
236

FIG. 4

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 95/00732

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 F16F15/124 B25F3/00 B25B23/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16F B25F B25B B25D B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No |
|---|---|---|
| A | US,A,3 463 048 (P.J.OWSEN) 26 August 1969<br>see the whole document<br>--- | 1,16 |
| A | US,A,3 312 260 (A.B.MAC NEILL) 4 April 1967<br>see the whole document<br>--- | 1-3,11,<br>13,16,22 |
| A | US,A,5 050 446 (K.TAKASHIMA ET AL.) 24 September 1991<br>see column 3, line 37 - line 45; figure 5<br>--- | 1,16 |
| A | GB,A,2 081 613 (ILLINOIS TOOL WORKS INC.) 24 February 1982<br>see abstract; figures 2,3<br>--- | 1,16 |
| A | US,A,2 704 681 (H.R.FISCHER) 22 March 1955<br>see claims; figures<br>---<br>-/-- | 1,16 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 14 March 1996 | 22/03/96 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax (+ 31-70) 340-3016 | Majerus, H |

Form PCT/ISA/210 (second sheet) (July 1992)

**INTERNATIONAL SEARCH REPORT**

International Application No
PCT/CA 95/00732

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US,A,2 464 381 (E.DONALDSON ET AL.) 15 March 1949<br>see column 1, line 14 - line 16; figures<br>----- | 1,16 |

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Inte... ional Application No
PCT/CA 95/00732

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US-A-3463048 | 26-08-69 | NONE | |
| US-A-3312260 | 04-04-67 | NONE | |
| US-A-5050446 | 24-09-91 | JP-B- 7030812 | 10-04-95 |
| | | JP-A- 63186048 | 01-08-88 |
| GB-A-2081613 | 24-02-82 | US-A- 4349929 | 21-09-82 |
| | | AU-B- 7180481 | 04-02-82 |
| | | CA-A- 1150453 | 26-07-83 |
| | | FR-A- 2487711 | 05-02-82 |
| | | JP-A- 57054017 | 31-03-82 |
| US-A-2704681 | 22-03-55 | GB-A- 731887 | |
| US-A-2464381 | 15-03-49 | NONE | |

THIS PAGE BLANK (USPTO)

## This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

## BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☑ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☑ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: ______________________

**IMAGES ARE BEST AVAILABLE COPY.**
**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**